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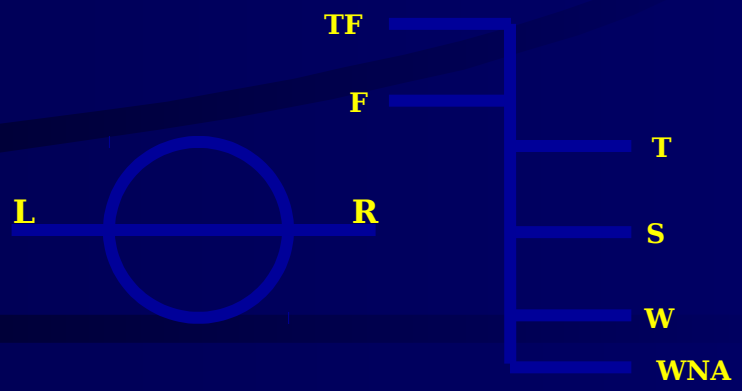

Planning Associates Program Curriculum (2011)

Deep-Draft Waterborne Navigation Economic Analysis – An Overview

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Deep-Draft Waterborne Navigation Economics - An Overview

- ***Institute for Water Resources (IWR)***
  - ***Navigation & Water Resources Applications; Group I (CEIWR-GI)***
  - *Instructor(s)*
    - *Ian A. Mathis (Economist); (7[illegible] 428-7257*

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Deep-Draft Waterborne Navigation Economics - An Overview

- ***Purpose***
  - *To provide an overview of the requirements and procedures for conducting deep-draft navigation economic analyses in accordance with standards and guidance as applied by the U.S. Army Corps of Engineers (USACE).*

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Deep-Draft Waterborne Navigation Economics - An Overview

- ***Objective(s)***
  - *Identify the General Concepts and Procedural Steps for Economic Analysis Applied to the Study of Deep-Draft Waterway Improvements Under National Economic Development (NED) Criteria.*
  - *Identify primary sources of guidance and data , and exposure to some of the general terminology applied for studies.*

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- **Primary References for Planning and Analytical Guidance**
  - *Water Resource(s) Council's (WRC) Economic and Environmental Principals and Guidelines for Water and Related Land Resources Implementation Studies* [alternatively identified as the Principals and Guidelines or "P&G")
  - *Engineering Regulation (ER) 1105-2-100* [alternatively identified as the *Planning Guidance Notebook* or "PGN"] *(continued)*

- **Primary References for Planning and Analytical Guidance** *(continued)*
  - *Planning Manual [IWR Report No. 96-R-21; November 1996]*
  - *National Economic Development (NED) Procedures Manual - Deep-Draft Navigation [IWR Report No. 91-R-13; November 1991]*
  - *Engineering Manual (EM) 1110-2-1613, Hydraulic Design Guidance for Deep-Draft Navigation Projects [April 1983 or as*

- *Secondary\Supplemental Reference(s)*
  - *Approach Channels - A Guide for Design [PIANC; International Navigation Association) Publication PTC-II-30; June 1997)*
  - *Economic Methods of Channel Maintenance [PIANC; International Navigation Association; Bulletin 67; 1989*
  - *Capability of Ship Maneuvering Simulation Models for Approach Channels and Fairways in Harbors [PIANC;*

- ***General Purpose(s) of Standardized Guidance***
  - *Provide Conceptual Basis for Economic Analysis of Benefits and Costs*
  - *Help to Define Planning Settings*
  - *Summarizes Practical Methodologies*
  - *Identifies Both Requirements and in Part Outlines Flexibility and Basic Steps of the Evaluation Process*

- ***Conceptual Basis for Benefits***
  - *The Reduction In The Value of (Economic) Resources Required to Transport Cargo or Commodities*

    and
  - *The Increase In The Value of Output for Associated Goods and Services*

- **Principal Direct Economic Benefits (& Basis for Measurement)**

  Elimination or Reductions in Transportation Cost(s) for……

  - *Benefits for Indigenous Markets and Related Maritime Operations*
  - *Benefits for Shift-of-Origin or Shift-of-Destination*
  - *Induced Movements*

- ***Elimination or Reductions In Transportation Costs(s)***
  - *Employment of Larger Vessels*
  - *More Efficient Use of Vessels*
  - *Lower Tug Assistance or Handlings Cost(s)*
  - *Reductions In Transit Time (Waterborne or Landside, etc.)*
  - *Use of Alternative Mode (Land vs.*

- ***Shift-of-Origin/Destination & Induced Movements Benefits***
  - *Shift-of-Origin/Destination - Realignment to/from Other Ports or Transport Facilities (typically to reduce costs)*
  - *Induced - Change in Mode or Scale of Cargo Throughput Activity and Related Cost(s) Via New or Unique Movements That Would Not Have Occurred or Existed Without Waterway Improvements*

- ***Planning Settings***
  - *Historical Conditions*
  - *Existing Conditions*
  - *Future Conditions*
    - *"With-Project"*
    - *"Without-Project"*

- ***Planning Settings - Criticality***

  Which is Most Important?

  - *Historical & Existing Conditions Have a Relative Context in Terms of How They Portend or Relate to the Future……*

  - *Future Conditions Generally Considered More Important; Most Pertinent to Project Economic Evaluation…… Future "With-Project" & "Without-Project" Conditions Are In Most Circumstances Equally Important & Deserving of Analytical Endeavor as the Relative Difference(s) Between These Settings is the Basis for Economic/Benefit Evaluation*

- ***"Without-Project" Condition(s)***
  - *In the General Context of Planning: The Most Likely Condition(s) Expected to Prevail Over the Planning Horizon in the Absence of a Specified Course of Action or Plan.*
  - *Specific to USACE Navigation Studies: The Most Likely Conditions Expected to Prevail Without the Implementation*

- **Without-Project Conditions**

  Basic Assumptions for All Studies

  – *Nonstructural Measures Have Been Implemented Where Viable (or Considered & Rejected).*

  – *Alternative Harbor Improvements Will Be Investigated and Foreseeable Developments Taken Into Account.*

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- **Without-Project Conditions** *(continued)*

Basic Assumptions for All Studies

- *Authorized Operation and Maintenance (O&M) Has Been and Will Continue (as Authorized) to be Performed.*
- *Sufficient Capacity of the Hinterland.*
- *Foreseeable Advance(s) in Technology and Industry Practices Applied as Appropriate.*

- ***"With-Project" Condition(s)***
  - *In the General Context of Planning: The Most Likely Condition(s) Expected to Prevail Over the Planning Horizon if a Given Course of Action or Plan is Implemented.*
  - *Specific to USACE Navigation Studies: The Most Likely Conditions Expected to Prevail and Uniquely Attributable to Implementation Proposed Improvements.*

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- *Basic Economic Criteria for Plan Formulation\Selection\Optimization*
  - *Plan, Alternative or Increment Where Net Economic Benefits (Above Project Costs) are Maximized……*

…Subject to Reasonable Assessment of Marginal or Incremental Economic Costs vs. Benefit(s) or Economic Return(s)

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Formulation\Selection of Plan Alternative

Project Reference Depth Alternative(s) (in Feet)	Avg. Annual Equivalent (AAEQ) Cost(s)	Avg. Annual Equivalent (AAEQ) *Total* Benefit(s)	Avg. Annual Equivalent (AAEQ) *Net* Benefit(s)
45.0 ft. (MLLW)	$13,000,000	$15,210,000	$2,210,000
46.0 ft. (MLLW)	$13,650,000	$16,107,000	$2,457,000
47.0 ft. (MLLW)	$14,469,000	$17,797,000	$3,328,000
48.0 ft. (MLLW)	$15,482,000	$18,888,000	$3,406,000
49.0 ft.	$24,152,000	$27,775,000	$3,623,000

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Formulation\Selection of Plan Alternative

Project Reference Depth Alternative(s) (in Feet)	Benefit-to-Cost (B\C) Ratio	(AAEQ) *Total* Benefit(s) Incremental % Change	(AAEQ) *Net* Benefit(s) Incremental % Change	
45.0 ft. (MLLW)	1.17	Not Applicable	Not Applicable	
46.0 ft. (MLLW)	1.18	5.897 %	11.176 %	
47.0 ft. (MLLW)	1.23	10.492 %	35.350 %	?
48.0 ft. (MLLW)	1.22	6.130 %	2.344 %	?
49.0 ft.	1.15	47.061 %	6.371 %	

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Formulation\Selection of Plan Alternative

Project Reference Depth Alternative(s) (in Feet)	Benefit-to-Cost (B\C) Ratio	(AAEQ) *Total* Benefits(s) Incremental % Change	(AAEQ) Total Costs(s) Incremental % Change	
45.0 ft. (MLLW)	1.17	Not Applicable	Not Applicable	
46.0 ft. (MLLW)	1.18	5.897 %	5.000 %	
47.0 ft. (MLLW)	1.23	10.492 %	6.000 %	?
48.0 ft. (MLLW)	1.22	6.130 %	7.001 %	?
49.0 ft.	1.15	47.061 %	56.001	

- ***Basic Steps of the Evaluation Process***
  - *As Presented by the Principals and Guidelines (P&G)*
  - *As Presented by the NED Procedures Deep- Draft Manual (IWR Report 91-R-13; November 1991)*
    - *Process is Not Characteristically Comprised of Rigid or "Discreet" Requirements in Terms of a*

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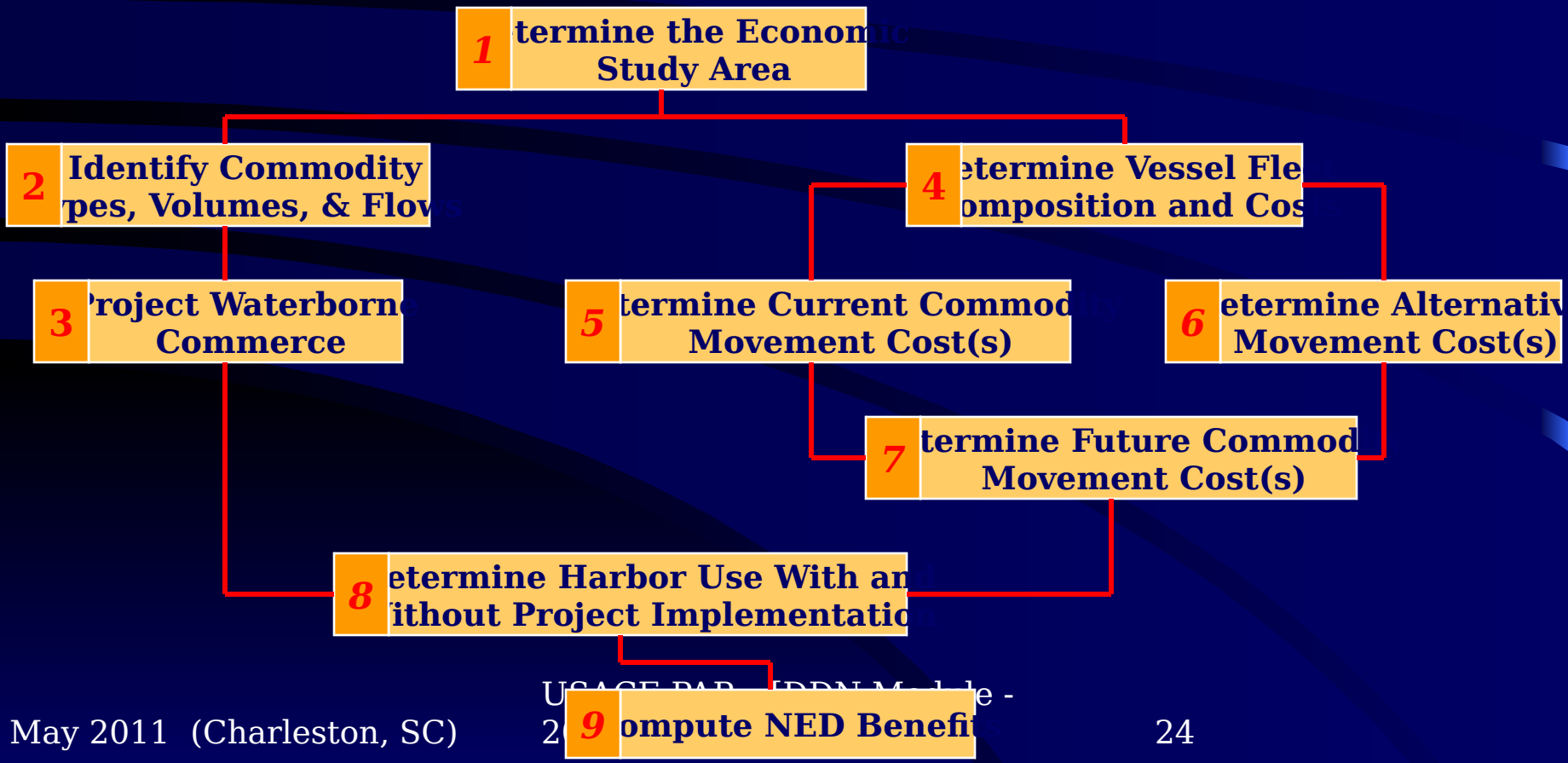
Deep-Draft Waterborne Navigation Economics - An Overview

C's P&G 9-Step NED Evaluation Process Schematic


1 termine the Economic Study Area
2 Identify Commodity pes, Volumes, & Flows
3 Project Waterborne Commerce
4 etermine Vessel Fle omposition and Cos
5 termine Current Commod Movement Cost(s)
6 etermine Alternativ Movement Cost(s)
7 termine Future Commod Movement Cost(s)
8 etermine Harbor Use With an ithout Project Implementatio
9 ompute NED Benefit

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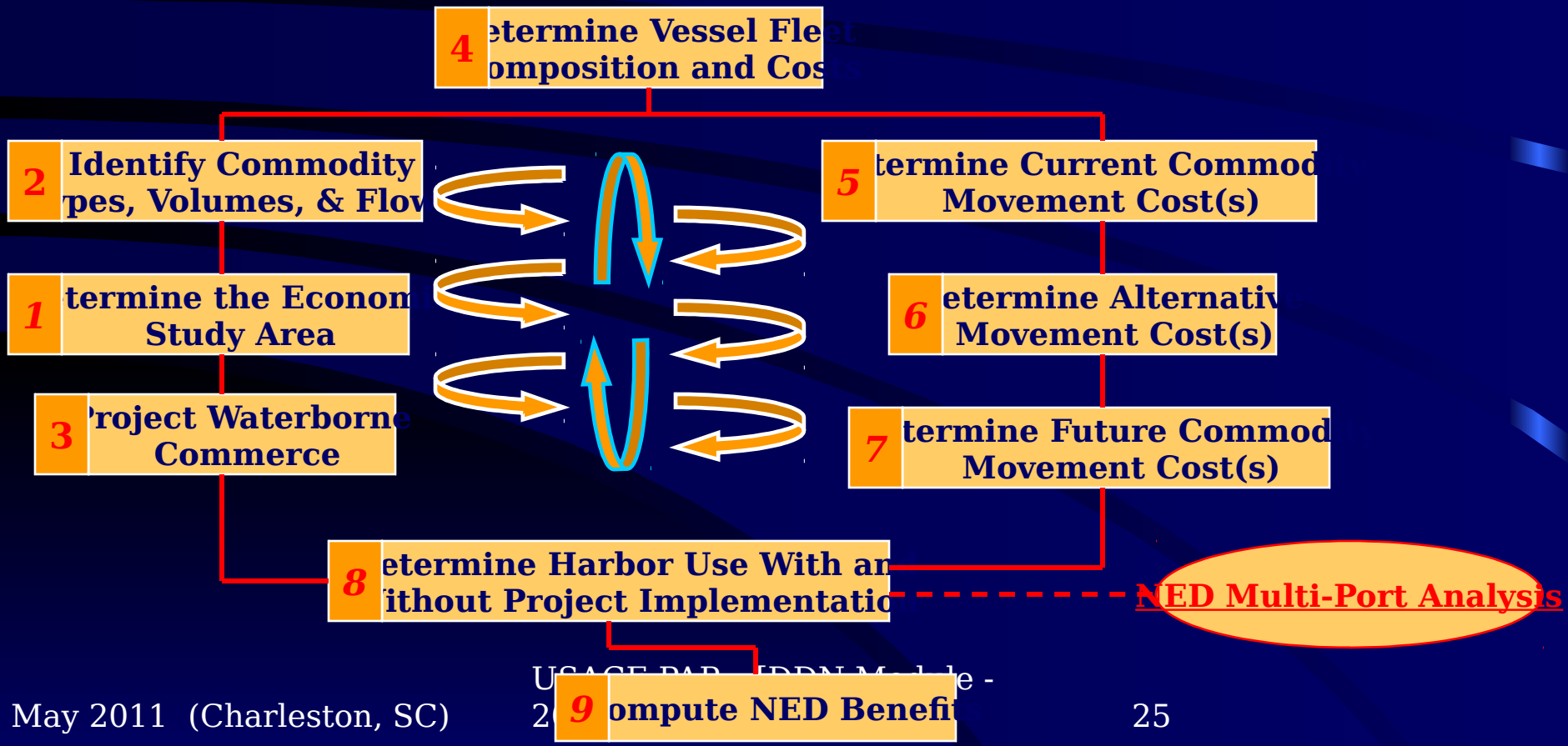
NED Procedures Deep-Draft Navigation Manual 9 Step Evaluation Process



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- ***Detail of the Basic 9-Step Process***

- **Vessel Fleet Service Composition Cost(s)**
  - *Historical Fleet Composition\Service Regime*
  - *Existing Fleet Composition\Service Regime*
  - *Future or Foreseeable Fleet Composition or Service Regime*
    - *"With-Project"*

- ***Identify Commodity Types, Volumes & Flows***
  - *Type of Movement*
  - *Origins & Destinations*
  - *Trade Routes*
  - *Number, & Magnitude or Scale of Movements*
  - *Frequency of Movements*
  - *Volume Per Unit of Time (i.e., generally*

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- ***Determine Economic Study Area***
  - *Area Considered Tributary to Proposed Harbor or Waterway Improvement(s)*
  - *Boundaries or Not Fixed or Rigid; May Overlap with Other Ports*
  - *May Vary by Commodity and/or Mode of Transport*
  - *May Vary Under Future/Changing*

- ***Determine Current Costs of Commodity or Cargo Transport***

  (With Regard to Origin/Destination as Appropriate)

  – *Ocean Transit Costs*

  – *Handling/Transfer Costs*

  – *Hinterland/Tributary (Landside or Inland Waterway) Transit Cost(s)*

- ***Determine Alternative Movements Cost(s)***

  (Next Best Alternative(s); Applicable?)

  - *Lightering, Topping-Off, or Offshore Facilities*
  - *Transhipment Facilities*
  - *Pipelines*
  - *Traffic/Port Facility Management*
  - *Other Transport Modes*

- ***Determine Fleet Service Composition & Cost(s)***
  - *Existing Fleet or Vessel Service*
    - *Type (Bulk,Tanker, Containerized Carrier, etc.)*
    - *Vessel Physical Characteristics (Size or Class, etc.)*
    - *Trade Routes*
    - *Commodities or Cargo Handled*

- ***Project Waterborne Commerce***
  - *World Forecasts*
  - *National Forecasts*
  - *Trade Route Forecasts*
  - *Regional Forecasts*
  - *Port-Specific Forecasts*
  - *Facility-Specific Forecasts*
    - *Relative to Commodity\Cargo & Fleet Service Regime (Forecasts)*

- **Determine Future Commodity Movement Cost(s)**

  Relative to Foreseeable & Probable Changes In:

  - *Fleet Service and/or Composition*
  - *Port Logistics (Delays, Throughput Process, etc.)*
  - *Port Throughput Capacity (Undertaken Relative to Time & Resources)*

- ***Determine Harbor or Waterway System Use Under "With" &\vs. "Without-Project" Conditions***
  - *Analyze Changes in Cost(s) Functions & Demand Schedules*
  - *Integrate Multi-Port Analysis (as Appropriate)*
  - *Determine or Assess Uncertainty or Potential Variability in Harbor Use*

- **Calculate or Quantify National Economic Development (NED) Benefits**

  (Cost Reduction Benefits - Examples)

  – *Same Cargo Flow, Origin/Destination, Harbor; Change in Vessel Efficiency (loading, time, etc.)*

  – *Same Cargo Flow, Origin/Destination, New or Alternative Harbor*

  – *Same Cargo Flow, Origin/Destination, Alternative Mode.*

- Bulk Carrier Exercise(s) *[Optional & Self Directed]*;
  - What are the average costs of coal delivery for a given class of bulk carrier with waterway depths of 38.0 versus another depth? Influence of changing operating costs?..... Influence of changing immersion?

- Logical Structure for Tabulations
  - Variable "Groupings"
    - Vessel Specifications
    - DWT vs. Cargo Tonnage & Stowage Characteristics
    - Immersed Draft & Waterway Depth Required
    - Time & Costs of Vessel Transit or Service
    - Per Unit Cargo Cost & Benefits

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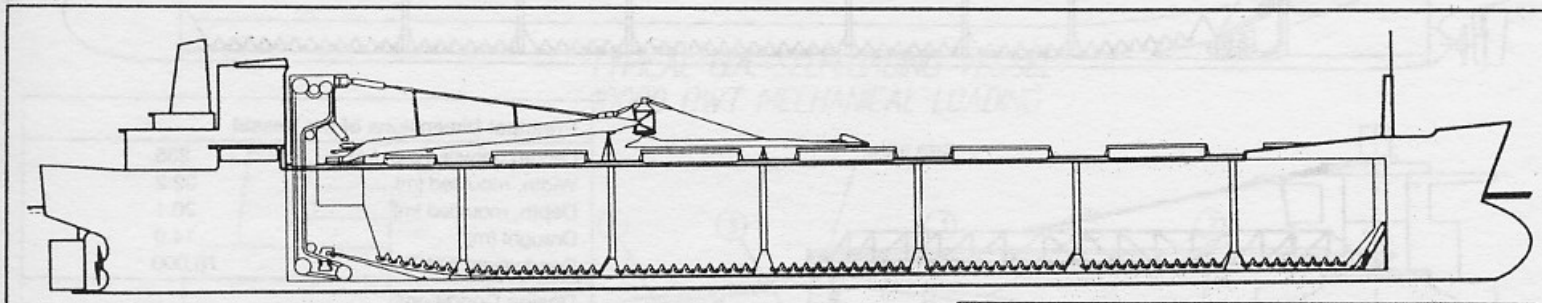
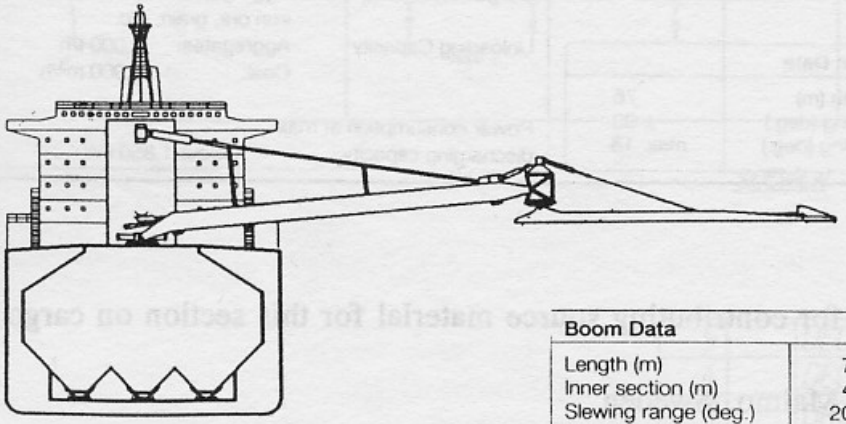
Figure C





Self-unloading gear of the CSL INNOVATOR

Boom Data	
Length (m)	76
Inner section (m)	46
Slewing range (deg.)	200
Outer section (m)	30
Slewing range (deg.)	300

Principal Dimensions of the Vessel	*Innovator*	*Atlas*
Length overall (m)	227.7	227.4
Length between p.p. (m)	214.5	221.4
Width, moulded (m)	32.23	32.0
Depth, moulded (m)	14.2	19.2
Draught (m)	13.5	13.35
Deadweight (DWT)	62,500	67,800

Design Conditions			
Cargo	*Coal*	*Iron ore*	*Limestone*
Bulk density (t/m^3)	0.8	2.2	1.2
Max. lump size (mm)	50	50	400

Unloading Capacity	
Tunnel belt conveyors	1,500 m^3/h or 1,500 t/h
Cross conveyors	1,500 m^3/h or 1,500 t/h
Flexolift vertical conveyor (2x)	2,200 m^3/h or 2,250 t/h
Boom conveyor	4,400 m^3/h or 4,500 t/h

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Deep-Draft Waterborne Navigation

General Vessel Description:	*Bulk Carrier of Aggregate Foreign Registry; Self Propelled*
Cargo or Lading:	Broken\Crushed Coal
Vessel Specifications (Self-Propelled Bulk Carrier)	
Deadweight Tonnage (DWT, in metric tonnes)	67,490
Deadweight Tonnage (DWT, in short tons)	74,390
Cargo-toTotal-Deadweight Coefficient or Ratio	0.918
Cargo Deadweight Tonnage (DWT, in metric tonnes)	61,956
Gross Registered Tonnage (GRT, in metric tonnes)	36,330
Net Registered Tonnage (NRT)	?
Length Overall (LOA, in feet)	731.4
Length Between Perpendiculars (LBP, in feet)	700.4
Beam or Breadth (in feet)	105.9
Maximum SLLD (Summer Loadline) Draft (in feet)	43.5
Underkeel Clearance (in feet; static condition)	3.0
Service Speed (estimated SS; in knots)	14.5
Applied Average Transit Speed At Sea (in knots)	13.3
Bulk Solid Capacity (Volumetric Capacity; cubic metres)	
Grain	78,620
Bale Cubic	75,480
Self-Discharge Rate (cubic meters per hour)	4,350
Immersion (TPI; tonnes, calculated IWR)	164.33
Immersion (TPI; tonnes, adjusted; working)	160.41
Applied Vessel Operating Cost At-Sea ($/hour)	$903
Applied Vessel Operating cost In-Port ($/hour)	$743

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Deep-Draft Waterborne Navigation Economics - An Overview

General Description of Cargo Movement and Waterway Depths	
Nature of Cargo Movement or Lading:	Bulk Broken\Crushed Coal
Nature of Trade\Direction:	Import\Inbound
Cargo Tonnage Per Year (Metric Tonnes):	4,500,000
Origin:	South America
Destination:	Tampa Bay, Florida (United States)
Approximate In-transit Distance (NM); Unladen:	480.0
Approximate In-transit Distance (NM); Laden:	1,340
Cargo Density\Stowage Requirement(s):	
- Pounds per Cubic Foot	55.0
- Pounds per Cubic Meter	1,942.6
- Metric Tonnes per Cubic Meter	0.881
Applied Channel Depth(s) (feet)	
Colombia (Various)	50.0
Tidal Influence\Variation:	Not Significant
United States (Tampa, Florida)	38.0
Tidal Influence\Variation:	Not Significant

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Without-Project Condition (38-Foot Depth)	
Waterway Reference Depth (feet):	38.0
Cargo Tonnage Per Year:	4,500,000
Vessel Transit Draft (feet):	35.3
Average Cargo Tonnage Per Vessel Call:	48,014
Number of Trips or Vessel calls Required Per Year:	93.7
Self-Discharge Rate (cubic meters per hour):	4,350
Self-Discharge Rate (metric tonnes per hour):	3,833.0
Hours In-Port Loading\Unloading (South America):	6.3
Hours In-Port Loading\Unloading (United States); Self Discharge:	12.5
Hours in Port; Other Reqirements:	2.0
Total Vessel Hours In-Port:	20.8
Vessel Operating Cost In-Port ($/hour):	$743
Total Vessel Costs In-Port:	$15,473
Distance; Transit At-Sea:	1,820
Applied Transit Speed At-Sea:	13.3
Total Hours In-Transit At-Sea:	136.7
Vessel Operating Cost At-Sea ($/hour):	$903
Total Vessel Costs At-Sea:	$123,435
Total Vessel Operating Costs for Cargo Delivery:	$138,907
Average Estimated Cost Per Tonne of Cargo:	$2.893
Total Vessel Delivery Cost(s) Per Year:	$13,018,722

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With-Project Condition (48-Foot Depth)	
Waterway Reference Depth (feet):	48.0
Cargo Tonnage Per Year:	4,500,000
Vessel Transit Draft (feet):	42.5
Average Cargo Tonnage Per Vessel Call:	61,956
Number of Trips or Vessel calls Required Per Year:	72.6
Self-Discharge Rate (cubic meters per hour):	4,350
Self-Discharge Rate (metric tonnes per hour):	3,833.0
Hours In-Port Loading\Unloading (South America):	6.3
Hours In-Port Loading\Unloading (United States):	16.2
Hours in Port; Other Reqirements:	2.0
Total Vessel Hours In-Port:	24.5
Vessel Operating Cost In-Port ($/hour):	$743
Total Vessel Costs In-Port:	$18,179
Distance; Transit At-Sea:	1,820
Applied Transit Speed At-Sea:	13.3
Total Hours In-Transit At-Sea:	136.7
Vessel Operating Cost At-Sea ($/hour):	$903
Total Vessel Costs At-Sea:	$123,435
Total Vessel Operating Costs for Cargo Delivery:	$141,613
Average Estimated Cost Per Tonne of Cargo:	$2.286
Total Vessel Delivery Cost(s) Per Year:	$10,285,721

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Summary of Annual Reductions(s) in Waterborne Transportation Costs	
Without-Project Condition(s)	$13,018,722
With-Project Condition(s)	$10,285,721
Net Reduction With Increased Depth	$2,733,001

- General Economic Principles
  - Life-Cycle Evaluation
    - Concepts
      - Incremental vs. “Sunk” costs
      - Financial vs. Economic Costs
      - Inflation vs. Time Value of Money
      - Opportunity Costs
      - Average Annual Value vs. Average Annual Equivalent (AAEQ)
      - Present Worth & Equivalency
      - Interest vs. Discount Rate(s)

- **Notable Economic Evaluation Considerations**
  - *Issues of Incremental Analysis*
  - *Non-Standard Procedures (Needs Approval)*
  - *Issues of Associated Cost(s)*
  - *Issues of Interest During Construction (IDC)*
  - *Issues of Benefits During Construction (BDC)*

- **Notable Economic Evaluation Considerations**

(continued)

  - Applicability of Systems\Multi-port Analysis (Interport vs. Intraport)
  - Underkeel Clearance Analysis\Assessment
  - Qualitative Assessment of Safety vs. Quantitative Economics
  - Plan Formulation Relative to:
    - Incremental Justification
    - Separable and Non-Separable (Joint) Benefits

(continued)

- ***Notable Economic Evaluation Considerations***

  (continued)

  - *Vessel Load Parameter(s) and Logistics*
  - *Sensitivity Analysis (Single and Multi-Variable)*
  - *Risk & Uncertainty (R&U)*
  - *Implications of Federal Cost Sharing*
  - *Other(s)?*

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Deep-Draft Waterborne Navigation Economics - An Overview

- **Navigation Data & Related Sources - General**
  - *Required Sources are Multiple or Numerous……Currently There Does Not Exist One Singular Source Applicable to the Needs of USACE Deep-Draft Navigation Studies*
  - *Not Always Readily or Consistently Available in Desired Level of Detail or in Time Series for All Studies*
  - *Sources Often Require Notable Lead and Labor Time to Acquire & Compile, Reconcile, and Refine*
  - *Applicable Sources Include Governmental & Private-Sector Entities*
  - *Some Critical Sources are Commercially-Based and Require Purchase for Acquisition*
  - *Nature of Data Requires Update or Currency for Reasonable Analysis (reference*

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- *General Guideline for Level of Effort for Process or Analysis*
  - *Undertaken Until It Is or Can be Determined Additional Significant Effort or Analysis Would Not Yield or Result In a Significant Variance in Finding Concerning Disposition for Both Justification & Plan Formulation…..*

…….Subject to Time and Budgetary Constraints for Studies…….Unless BC Ratio….

- ***National Economic Development (NED) Considerations for Analysis of Cost(s)***
  - *Issues of Federal vs. Non-Federal Costs*
  - *Construction or Placement Cost(s)*
  - *Operation & Maintenance (O&M) Costs(s)*
  - *Interest During Construction (IDC)*

- *Potential Questions or Issues With Analysis\Formulation*
  - *Differences or nuances of engineering vs. planning guidance;*
    - *Estimation of depth requirements; vessel clearance estimation, etc..*
  - *Differences or nuances in the interpretation of guidance;*
    - *Single-User Beneficiary, End-of-the-Line User\Beneficiary; Progressive Development Rationale; Marginal Specification vs. Marginal Justification\Need\Impact.*
  - *What is the role of vessel simulation relative to economic studies? Who often selects the*

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- *Potential Questions or Issue With Analysis\Formulation*

(continued)

  - *What is the role of vessel simulation relative to economic studies? What are the "Types" of Simulation Studies and who selects the vessel specifications and conditions for simulation studies? Why?*

  - *What information can be retrieved from vessel simulation studies for economic analyses?*

  - *What are some of the considerations for safety relative to economic analysis?*

- **Historical Findings of the Army Audit Agency (AAA)**
  - Economic benefits often or typically overstated (relative to intent of applied guidance)
  - General lack or absence of multi-port analysis
  - Commodity\cargo projections not current or updated as might otherwise be appropriate
  - Frequent inconsistencies in fleet service projections
  - Vessel\Carrier size often overstated or overestimated
  - Inconsistency(ies) in comparison of with vs

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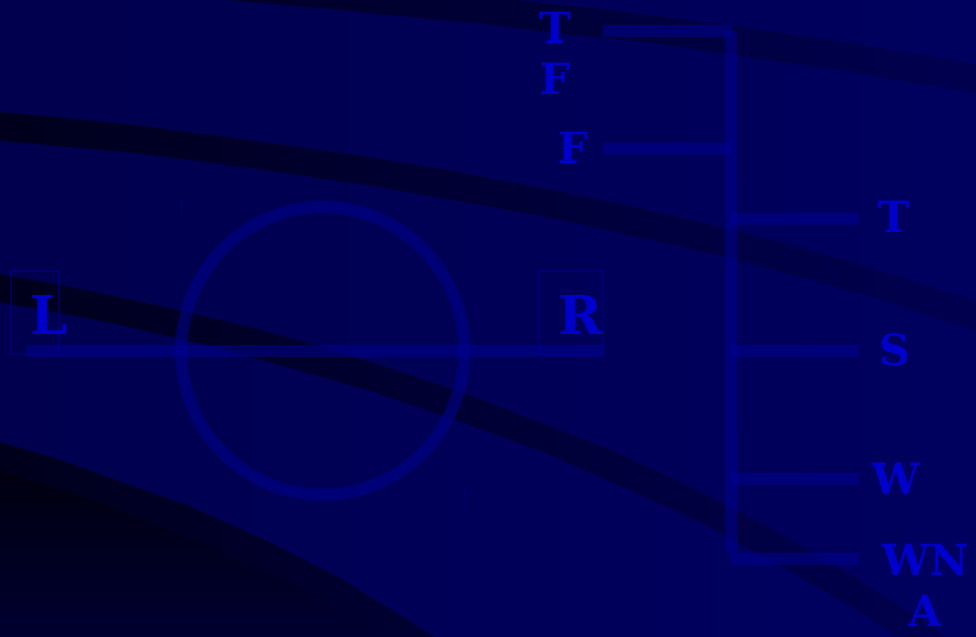
- Trivia……
  - What are these markings…
  - What is the meaning of the alphabetical labels…



- ***Open Period for Questions/Discussion***

- ***END***

- Notes or Questions:

- ***Short Break***

- 10 Minutes